Cold-Lightweight Imagers for Europa (C-LIFE)

Completed Technology Project (2016 - 2018)

Project Introduction

Europa and other Ocean Worlds may possess extant life; sending a lander has become a high priority. Several types of imaging are needed to advance the science and operations. Cold-Lightweight Imagers for Europa (C-LIFE), is an instrument suite containing a stereoscopic color imager (SI) and a uniocular microscopic polarizing imager (MI). The SI achieves resolutions of 1 mm/pixel from a range of 3m in 3 color filters, while the MI illuminates samples with filtered LEDs and characterizes ice grains and non-ice materials down to plate scales of 10 microns/pixel. C-LIFE objectives are to: (1) Search for evidence of biomarkers and/or life, particularly with the microscopic imager; (2) Characterize surface properties and local geologic context; and (3) Guide surface activities for sample collection. Small cameras on landed missions represent a mature technology for missions to Mars, but not in the thermal and radiation environments of Europa and other Ocean Worlds, especially given severe mass and power limitations. For example, mass and power limitations drive us to use small pixel format CMOS detectors that lack adequate testing. We expect electronics inside the shielded lander will have a high TRL, but the external camera components require development to meet the challenging requirements such as very low mass and power, radiation tolerance, and planetary protection protocols. The University of Arizona Lunar and Planetary Laboratory (UA LPL) plans to propose such an instrument concept for a Europa lander and other Ocean-World landers in the future. The UA team has extensive relevant experience, including Phoenix SSI and RAC, Cassini-Huygens DISR, Mars Pathfinder IMP and, most recently, OSIRIS-REx OCAMS. In this COLDTech effort, we advance the qualification of several key elements of C-LIFE in readiness for flight opportunities to Ocean Worlds by: (1) Developing a detector testbed capable of down-selecting candidate CMOS devices, (2) Testing CMOS detectors, filters and micro-polarizing arrays in relevant environments, (3) Measuring the refractive indices of rad-hard lenses at ocean-world temperatures, (4) Fabricating and testing a Sample Transport Mechanism to deliver samples to the MI and (5) Constructing engineering models of the MI and SI and testing in relevant environments. We expect the key subsystems to progress from TRL 3 or 4 to TRL 5 or 6 via this proposed effort. To achieve these goals we are partnering with the Space Dynamics Laboratory (SDL), which provides some key capabilities and facilities to complement those at UA. Together with our SDL partners, we will thermal and radiation test a number of promising new commercial off-the-shelf CMOS detectors to identify the best candidate for C-LIFE. We will also collaborate with industrial partners such as e2v and ONSemi for detectors, 4D Technology for micropolarimeter arrays and PIXELTEQ for filters. Prototypes of the successful SI and MI design will be fabricated and tested under relevant environments at UA to achieve TRL 5/6. Increasing the technical readiness of C-LIFE directly addresses COLDTech objectives to develop and advance the maturity of science instruments focused on understanding habitability and the detection of evidence of life in the ocean worlds of the outer Solar System. Recommendations of the upcoming Europa Lander Science Definition Team

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Concepts for Ocean Worlds Life Detection Technology

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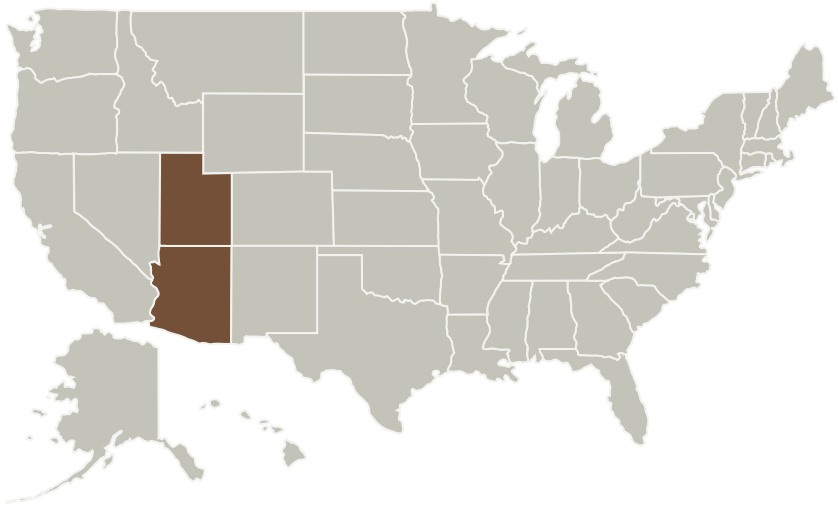
Report will be folded into our design to the extent possible when the report becomes available.

Anticipated Benefits

C-LIFE is an imaging system capable of operating on ocean world surfaces and is especially relevant to the upcoming (but still unfunded) Europa Lander. In this COLDTech effort we qualify detectors and micropolarizer arrays at cryogenic temperatures as well as quantify how excesses of chirality (a biologic signature) can be detected by light polarization.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Arizona	Supporting Organization	Academia Alaska Native and Native Hawaiian Serving Institutions (ANNH), Hispanic Serving Institutions (HSI)	Tucson, Arizona

Project Management

Program Director:

Carolyn R Mercer

Program Manager:

Carolyn R Mercer

Principal Investigator:

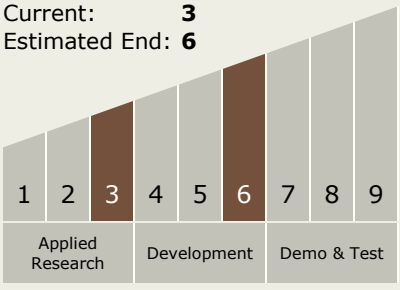
Shane Byrne

Co-Investigators:

Samuel H Bailey
Matthew Chojnacki
Jed J Hancock
Isamu Matsuyama
Shana M Mcclelland
Peter Smith
Alfred S Mcewen
Adam Showman
Daniella N Della-giustina
Christian Y Drouet D'aubigny
Veronica J Bray
Bashar Rizk

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **6**



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Primary U.S. Work Locations	
Arizona	Utah

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destination

Others Inside the Solar System